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BIOMETRIC PROPERTIES OF EURYHALINE FISH THE SAND SMELT *ATHERINA BOYERI* RISSO, 1810

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ABSTRACT: In this study the presence of sand smelt *Atherina boyeri* Risso, 1810, an invasive and translocated species has been reported in the Hirfanlı Dam Lake, Turkey. The fish samples were collected from the fishermen operating in the area in April 2016. Twenty-three morphometric characteristics of *A. boyeri*, were taken, including standard length (SL), fork length (FL), total length (TL), preorbital distance, eye diameter, interorbital distance, head length, head width, dorsal fin I nose point distance, dorsal fin II nose point distance, preanal distance, prepectoral distance, preventral distance, dorsal fin I base length, dorsal fin II base length, anal fin base length, pectoral fin base length, ventral fin base length, maximum body height, caudal peduncle height, body width, caudal peduncle width, body weight (W). The SL varied between 62 to 75 mm and weight 2.324 to 4.133 g in females. Whereas in males the SL varied between 56 to78 mm and weight 1.533 to 4.011 g. The sex ratio was slightly in favour of females being 54.4%.

KEYWORDS: *Atherina boyeri*, sand smelt, biometric properties, euryhaline fish

INTRODUCTION

The big-scale sand smelt *Atherina boyeri* Risso, 1810 lives in fresh, brackish and marine waters of the western Atlantic Ocean and Mediterranean Sea *(*Milana *et al.*, 2008*). Atherina boyeri* is euryhaline: the adults migrate to sea in autumn and enter the lagoons in spring for reproduction (Congiu *et al.*, 2002). The field of fisheries science has used many tools, such as genetic and morphometric characteristics to distinguish groups of fish (Mir *et al.*, 2013). Morphometric assessment is also used in the identification of the differences in fish population (Tzeng, 2004; Cheng *et al.*, 2005; Buj *et al.*, 2008). The morphological differences based on general body type or unusual anatomical forms are used to distinguish and compare species and groups in fish (Strauss and Bond, 1990). Morphometric characteristics of fish are studied widely through the use of classical dimensions (Strauss and Bond 1990; Park *et al.*, 2007). Morphometric assessment of an animal species determines the inter relation between the body parameters like length, weight, fecundity and so on (Carpenter *et al.*, 1996).

Atherina boyeri is considered as a polymorphic complex in the literature (Kiener and Spillmann, 1969). They are carnivorous, feeding on small crustaceans, worms, mollusks and fish larvae (Quignard and Pras, 1986). Based on the prey composition abundance, *A. boyeri* is considered to be an opportunistic predator (Bartulovic *et al.*, 2004; Doulka *et al.*, 2013) that can feed both on planktonic or benthic invertebrates (Rosecchi and Crivelli, 1992).

In recent years, *A. boyeri*, a marine species, has been found to expand its distribution in the inland waters (Ekmekçi *et al.*, 2013; Innal and Erkakan, 2006). *A. boyeri* in terms

of distribution is both a native and translocated fish in Turkish waters (Innal and Erkakan, 2006). According to Tarkan *et al.* (2014) any translocated or invasive fish species may cause problems to the native fish fauna by producing exotic diseases and parasites (Innal and Erkakan, 2006; Tarkan *et al.*, 2014). *A. boyeri* is in the category of IUCN Red List LC (Least Concern) (Freyhof ve Kottelat, 2008).

The non-native fish species *Pseudorasbora parva* and native *Aphanius danfordii* are also abundant in the reservoir. These species share the same habitat as *A. boyeri* (Ekmekci *et al.*, 2010). The presence of *Aphanius danfordii, A. boyeri, Pseudorasbora parva, Cyprinus carpio, Tinca tinca* and *Sander lucioperca* species is reported in the Hirfanlı Reservoir (Kırankaya *et al.*, 2014; Gençoğlu and Ekmekçi, 2016; Benzer et al, 2009; Gül *et al.*, 2011). The fishermen engaged in commercial hunting in the Hirfanlı Dam Lake were hunted by *A. boyeri* while hunting *Aphanius marassantensis* and *Pseudorasbora parva*.

Several biological studies have been conducted on *A. boyeri* in different water bodies of Turkey, such, as, study of some biological characteristics (Altun, 1986; Sezen, 2005; Tarkan *et al.*, 2012), variations in growth and life history traits t (Tarkan *et al.*, 2007;Çetinkaya *et al.*, 2011); biometric properties, length–weight and length–length relationships (Taskavak *et al.*, 2012; Kırankaya *et al.*, 2014; İlhan and Sarı, 2015; İlhan and İlhan, 2018); reproductive features of big scale sandsmelt *(*Küçük *et al.*, 2012) and growth and reproduction of a marine fish, *A. boyeri* (Gençoğlu and Ekmekçi, 2016). The other studies conducted on *A. boyeri* include the resettlement of *A. boyeri* in Turkey reserviors (Saç *et al.*, 2016); new record of the big-scale sand smelt in the Devegecidi Dam Lake (Ünlü *et al.*, 2017); Süreyyabey Dam Lake (Benzer, 2018); and in the Seyhan Dam Reservoir (Çevik *et al.*, 2018). The growth models of big-scale have also been studied (Benzer and Benzer, 2017).

In the present study the morphometric characteristics of individuals of *A. boyeri* were measured in the Hirfanlı Dam Lake and compared with the results of previously mentioned studies on the same species in other dams of Turkey.

MATERIALS AND METHODS

The study was carried out in Hirfanlı Dam Lake (Fig. 1), which was constructed in 1959, on river Kızılırmak, 70 km far from the south of Kırıkkale. It is located at 856 m altitude with a capacity of 7.63 x 109 m^3 and an area of 320 km^2. The depth, length and width of the lake are 58 m, 90 and 15 km, respectively. It is 24 km far from Ankara - Kırşehir Highway and 30 km from Ankara-Adana highway (DSİ, 1968).

During the study, 35 specimens of *A. boyeri* were collected from fishermen operating in the area of Hirfanlı Dam Lake in April 2016. The samples were preserved in 4% formaldeyde solution and all lengths were measured to the nearest 0.1 mm and the weight was taken to the nearest 0.01g. The following measurements were taken as described in Fig. 2.

Sex was determined by examining gonads after dissection of fish. Statistical analyses (SD, CI confidence interval, margin of error, lower bound) were performed using SPSS software.

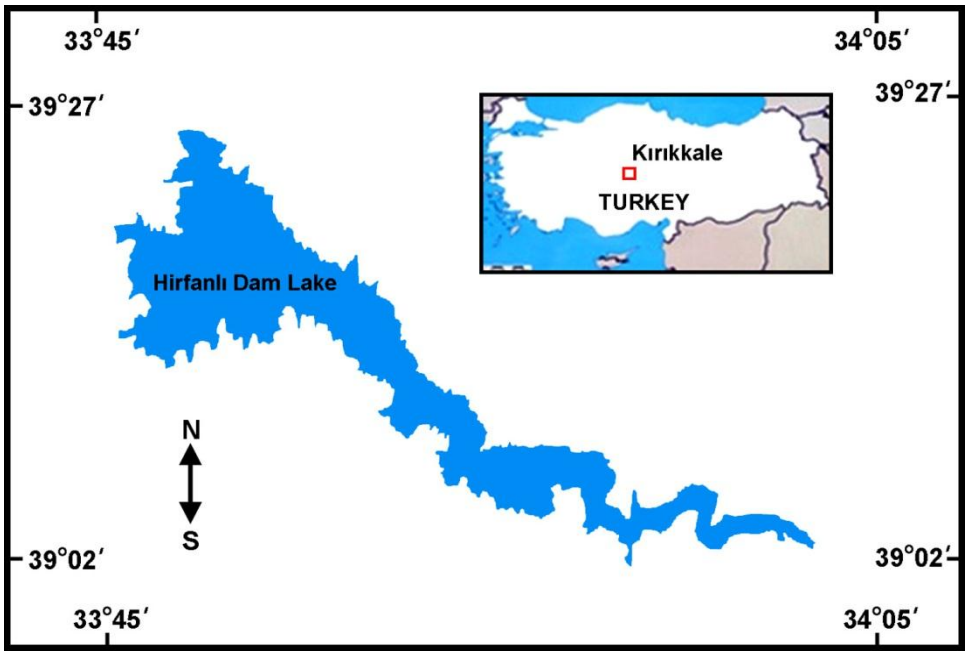

Fig. 1. Hirfanlı Dam Lake.

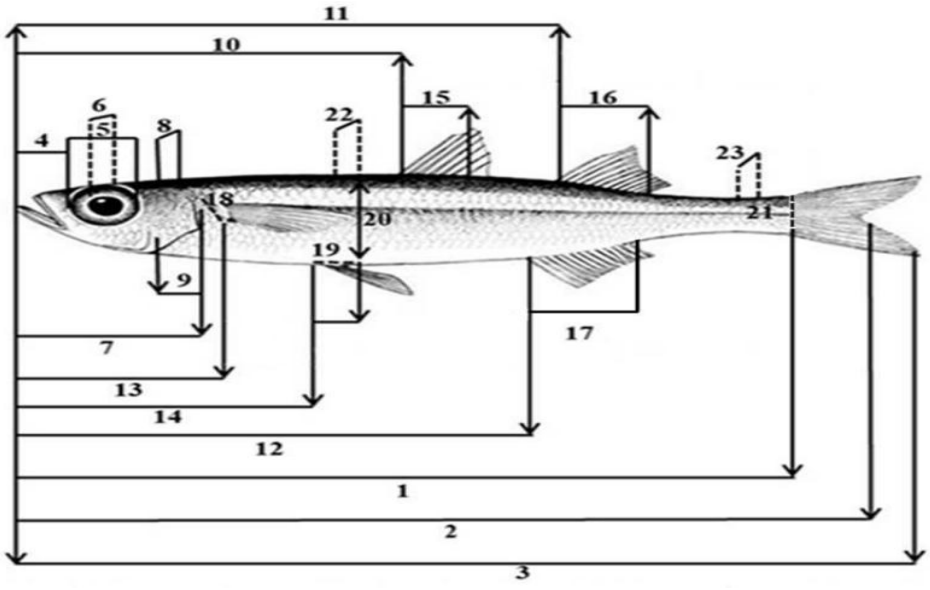

Fig. 2. Metric measurements taken on *A. boyeri* (Bostancı *et al.*, 2014).

As in Figure	Metric measurements
1	Standard Length
2	Fork Length
3	Total Length
4	Body Weight
5	Preorbital distance
6	Eye diameter
7	Interorbital distance
8	Head length
9	Head width
10	Dorsal fin I nose point distance
11	Dorsal fin II nose point distance
12	Preanal distance
13	Prepectoral distance
14	Preventral distance
15	Porsal fin I base length
16	Dorsal fin II base length
17	Anal fin base length
18	Pectoral fin base length
19	Ventral fin base length
20	Maximum body height
21	Caudal peduncle height
22	Body width
23	Caudal peduncle width

RESULTS AND DISCUSSION

Measurements of 35 specimens of *A. boyeri* conducted during this study are given in Table 1. The Standard length of 35 individuals ranged between 56 to 78 mm (Table 1). The sex of fish showed there were 54.4 % females and 44.9 % males. Minimum total weight was measured as 2.324 g, maximum total weight as 4.133 g, and average total weight was calculated as 3.467g for females. Minimum total weight was measured as 1.533 g, maximum total weight as 4.011g, and average total weight was calculated as 2.801 g in males. Head length varied between 13.0 mm – 17 mm in females and 10 mm – 19 mm in males.

A comparison of various lengths and weight of *A. boyeri* in the present study was made with the same species found at other locations in Turkey waters (Table 2). The average values of total length, fork length, standard length and weight of *A.boyeri* in the present study from Hirfanlı Dam Lake (Table 2) were less than the average length and weight of this species collected from Seyhan Dam Reservoir (Çevik *et al.,* 2018) and greater than the average length and weight collected from Süreyyabey Dam Lake (Benzer, 2018) and from Devegeçiti Dam Lake (Ünlü *et al.,* 2017). The average head

length of *A. boyeri* in the present study was 14.88±1.81 mm which is greater than the average head length value of the same species in the Turkish waters reported by by other authors, being 12.9±1.64 (Cevik *et al.* 2018), 11.89±2.19 (Benzer, 2018) and 9.6±1.1 (Ünlü *et al.*, 2017) (Table 2).

Table 1. Morphometric characters of *A. boyeri* specimens.

	Parameters	Min (cm)	Max (cm)	Average (cm)	SD	CI	Margin of error	Upper bound	Lower bound
	FEMALE								
1	Standard Length	6.200	7.500	6.953	0.344	0.174	0.015	7.127	6.779
2	Fork Length	6.700	8.100	7.493	0.383	0.201	0.021	7.694	7.292
3	Total Length	7.100	8.600	7.936	0.409	0.214	0.023	8.150	7.722
4	Preorbital distance	0.300	0.600	0.480	0.068	0.034	0.001	0.514	0.446
5	Eye diameter	0.400	0.600	0.520	0.056	0.028	0.000	0.548	0.492
6	Interorbital distance	0.300	0.600	0.480	0.068	0.034	0.001	0.514	0.446
7	Head length	1.300	1.700	1.533	0.098	0.049	0.001	1.583	1.484
8	Head width	0.600	1.000	0.787	0.130	0.066	0.002	0.853	0.721
10	Dorsal fin I nose point distance	2.700	3.500	3.120	0.227	0.115	0.007	3.235	3.005
11	Dorsal fin II nose point distance	4.000	5.000	4.593	0.333	0.168	0.014	4.762	4.425
12	Preanal distance	4.000	5.000	4.593	0.284	0.144	0.011	4.737	4.450
13	Prepectoral distance	1.600	2.000	1.853	0.155	0.079	0.003	1.932	1.775
14	Preventral distance	2.300	3.200	2.773	0.260	0.132	0.009	2.905	2.642
15	Dorsal fin I base length	0.300	0.900	0.527	0.162	0.096	0.005	0.623	0.432
16	Dorsal fin II base length	0.700	1.000	0.893	0.103	0.052	0.001	0.946	0.841
17	Anal fin base length	0.700	1.200	0.967	0.129	0.065	0.002	1.032	0.901
18	Pectoral fin base length	0.100	0.500	0.280	0.108	0.055	0.002	0.335	0.225
19	Ventral fin base length	0.200	0.500	0.280	0.108	0.055	0.002	0.335	0.225
20	Maximum body height	1.000	1.900	1.347	0.223	0.113	0.007	1.460	1.234
21	Caudal peduncle height	0.300	0.500	0.440	0.063	0.032	0.001	0.472	0.408
22	Body width	0.600	1.300	0.960	0.206	0.104	0.006	1.064	0.856
23	Caudal peduncle width	0.300	0.600	0.433	0.082	0.041	0.001	0.475	0.392
24	Body Weight	2.324	4.133	3.467	0.467	0.236	0.029	3.704	3.231
	MALE								
1	Standard Length	5.600	7.800	6.860	0.460	0.202	0.021	7.062	6.658
2	Fork Length	6.100	8.100	7.335	0.450	0.197	0.020	7.532	7.138
3	Total Length	6.500	8.600	7.920	0.455	0.199	0.020	8.119	7.721
4	Preorbital distance	0.400	0.700	0.518	0.067	0.030	0.000	0.547	0.488
5	Eye diameter	0.400	0.600	0.490	0.055	0.024	0.000	0.514	0.466

Continued……..

6	Interorbital distance	0.300	0.600	0.448	0.090	0.039	0.001	0.487	0.408
7	Head length	1.000	1.900	1.455	0.221	0.097	0.005	1.552	1.358
8	Head width	0.500	0.900	0.690	0.097	0.042	0.001	0.732	0.648
10	Dorsal fin I nose point distance	2.500	5.200	3.265	0.653	0.286	0.042	3.551	2.979
11	Dorsal fin II nose point distance	3.700	5.700	4.605	0.432	0.189	0.018	4.794	4.416
12	Preanal distance	3.600	6.000	4.620	0.438	0.192	0.019	4.812	4.428
13	Prepectoral distance	1.300	2.000	1.630	0.215	0.094	0.005	1.724	1.536
14	Preventral distance	1.500	3.200	2.468	0.489	0.215	0.023	2.682	2.253
15	Porsal fin I base length	0.200	0.500	0.344	0.104	0.048	0.001	0.393	0.296
16	Dorsal fin II base length	0.200	1.000	0.605	0.216	0.095	0.005	0.700	0.510
17	Anal fin base length	0.300	1.100	0.780	0.217	0.095	0.005	0.875	0.685
18	Pectoral fin base length	0.300	1.900	1.095	0.456	0.200	0.020	1.295	0.895
19	Ventral fin base length	0.200	0.400	0.245	0.060	0.027	0.000	0.272	0.218
20	Maximum body height	0.900	2.000	1.278	0.245	0.107	0.006	1.385	1.170
21	Caudal peduncle height	0.300	0.500	0.450	0.061	0.027	0.000	0.477	0.423
22	Body width	0.500	1.100	0.690	0.145	0.063	0.002	0.753	0.627
23	Caudal peduncle width	0.200	0.400	0.225	0.055	0.024	0.000	0.249	0.201
24	Body Weight	1.533	4.011	2.801	0.576	0.253	0.033	3.053	2.548

Table 2. Some morphometric measurements of *A. boyeri* in present study and in literature. TL= Total length, FL = Fork length, Sl = Standard length, W = weight, HL = Head length, Ed = Eye diameter, IO = Interorbital distance, POL = Preorbital distance.

	Present study		**Çevik *et al.* (2018) from Seyhan Dam Reservoir**		**Benzer (2018) from Süreyyabey Dam Lake**		**Ünlü *et al.* (2017) from Devegeçiti Dam Lake**	
Metric	**Mean± SD**	**Range**	**Mean± SD**	**Range**	**Mean±SD**	**Range**	**Mean±SD**	**Range**
TL (mm)	79.26±4.30	65-86	83.8±9.50	72.1-100.1	66.1±5.40	58-78	47.0±4.2	43.3-59.9
FL (mm)	74.0±4.24	61-81	77.7±8.58	66.0-92	60.65±5.32	49-73	44.1±3.6	40.3-55.1
SL (mm)	69.0±4.11	56-78	72.1±7.70	61.0-85	56.93±5.50	41-68	40.7±3.4	37.7-50.9
W (g)	3.09±0.62	1.53-4.13	3.6±1.11	2.1-5.90	1.95±0.60	0.90-3.57	2.9±3.2	0.7-8
HL (mm)	14.88±1.81	10-19	12.9±1.64	10.9-16.0	11.89±2.19	8-16	9.6±1.1	8.4-12.9
ED	5.02±0.56	4-6	3.4±0.58	2.8-4.50	4.41±0.68	3-6	3.5±0.5	3.0-4.9
IO	4.61±0.81	3-6	2.6±0.43	2.1-3.10	3.69±0.81	3-7	3.2±0.2	2.6-3.4
POL	5.01±0.69	3-7	3.9±0.82	2.1-5.50	3.84±0.89	2-6	3.5±0.4	3.0-4.6

Morphometric characters are not only essential to understand the taxonomy but also the health of a species as well as its reproduction in an environment. The shape and structures are unique to each species and the variations in its features are probably related to the habit and habitat among the variant of the species (Carpenter *et al.*, 1996).

It is reported that morphometric characters may vary not only in populations, but also in the region (Chan, 2001). Apart from the morphometric diversity, there are differences in meristic features in the populations of the species at regional level (Fransisco *et al.*, 2008). Using standard measures in all populations is important in terms of reflecting more real results in comparison of populations Taşkavak *et al.*, 2012).

CONCLUSION

In this study, 23 morphometric characteristics of *A. boyeri* in Hirfanlı Dam Lake were investigated. . The present study reports for the first time the data on *A. boyeri* in that area and describes the area where this fish were recorded.

The findings obtained in this study are important to compare it with previous studies on the morphometric characteristics of *A. boyeri*, as it has been reported that morphometric characters change not only among the populations but also in various regions (Chan, 2001). The data obtained in this study will also contribute in future studies on the various biological aspects of this species.

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